



## Demonstration Bulletin

### GRACE Dearborn Inc. DARAMEND™

#### Bioremediation Technology

**Technology Description:** The DARAMEND™ Bioremediation Technology may be applied to the remediation of soils and sediments contaminated by a wide variety of organic contaminants including chlorinated phenols, polynuclear aromatic hydrocarbons (PAHs), and petroleum hydrocarbons. The technology may be applied *ex situ* to sediment and soil and *in situ* to near surface soils. The DARAMEND™ technology stimulates indigenous soil microorganisms to accelerate the degradation and destruction of soil contaminants. The process consists of three integrated treatment components: 1) amendment addition, 2) specialized tilling, and 3) water irrigation. The technology is based upon the addition of solid phase organic amendments of a specific particle size distribution. These amendments are supplemented with controlled released macronutrients and trace elements. The amendments increase the ability of the soil matrix to supply biologically available water and nutrients, to stimulate indigenous contaminant-degrading soil microorganisms. The amendments also bind contaminants to reduce the acute toxicity of the soil's aqueous phase, thereby allowing microorganisms to survive in soil containing very high concentrations of contaminants. The volume of amendments added varies between 1% and 5% of the total weight of the soil. In some cases amendment(s) are added only in the beginning of the treatment process, however sometimes 10% of the original amount of amendment(s) is added midway or near the end of treatment depending on analytical results. The type, volume, and frequency of amendment(s) addition is determined through treatability and pilot-scale studies.

After addition of the soil amendment(s) the water holding capacity (WHC) of the soil-amendment mixture is determined. The plot is then irrigated to maintain soil water content in the optimum range to encourage biodegradation while preventing the generation of leachate. The soil is tilled by specially designed tillers immediately after irrigation, and at two-week intervals thereafter, to increase diffusion of oxygen to microsites and to ensure uniform distribution of irrigation water in the soil profile. The tiller blades are capable of reaching a depth of 60 cm. The frequency of irrigation is determined by weekly monitoring of soil moisture conditions.

**Materials Handling:** Technology application requires contaminated soil to be screened to approximately 10 cm to remove debris (rocks, wood, metal) that could interfere with the incorporation of the organic amendments. *In situ*, soil is screened

to a depth of 60 cm using equipment such as subsurface combs and agricultural rock pickers. *Ex situ*, the soil is passed over a mechanical screen. For *ex situ* application, screened soil is transported to the treatment area and deposited into a low permeability cell (an high density polyethylene-lined earthen cell or a concrete cell). If the soil is treated on a polyethylene liner, 10 cm of screened sand are deposited under the liner to prevent structural damage. Another sand layer (approximately 15 cm thick) and a 4 mm thick fiber pad are spread on top of the liner to minimize the potential for direct contact between the liner material and tillage equipment.

Once the upper bedding material has been uniformly spread, the screened soil is deposited to a uniform depth of 0.5 m. The amendment is then added and the soil/amendment is homogenized with a rotary tiller. Tilling reduces variation in the soil's physical and chemical properties and facilitates distribution of soil amendments. The tilled soil is covered by a waterproof temporary structure to protect the soil from precipitation and control soil moisture. The structure can either be a portable greenhouse or a polyethylene canopy.

**Waste Applicability:** The GRACE Dearborn Inc. DARAMEND™ Bioremediation Technology is applicable to a wide range of organic wood preservative contaminants. According to the developer, the technology has been proven effective at the pilot scale on soil contaminated with total PAHs up to 18,500 mg/kg, total petroleum hydrocarbons up to 8,700 mg/kg, and pentachlorophenol up to 660 mg/kg.

**Demonstration Results:** The GRACE Dearborn Inc. DARAMEND™ Bioremediation Technology was evaluated at the Domtar wood preserving site in Trenton, ON, Canada, between October 1993 and September 1994. The site treated wooden poles with solutions of creosote and pentachlorophenol until 1990. Soil contaminated with PAHs and pentachlorophenol was used for this SITE demonstration. The evaluation was conducted in a greenhouse in which two soil plots were established. A No-Treatment Plot (2 x 6 m) was established as a control and did not receive amendments, tilling, or irrigation for the duration of the project. A Treatment Plot (6 x 36 m) was established to evaluate the effectiveness of the amendments, tilling, and irrigation in degrading total chlorophenols and PAHs in the soil. The technology was evaluated over 254 days of treatment, but data was



collected only on those days when the soil temperature was greater than 15°C. Based on previous pilot scale tests, the developer claimed the process would achieve a 95% reduction in total PAHs and a 95% reduction in total chlorophenols.

Reductions achieved in the Treatment and No-Treatment Plots (based on preliminary results of the SITE demonstration) are shown in Table 1.

Although the developer fell slightly shy of these claims, it is likely that they would have met the targets if the demonstration had continued for several more months.

Toxicity tests (seed germination inhibition and earthworm mortality) of the baseline and treated soils indicate a significant reduc-

tion in toxicity in treated soil. There was no earthworm mortality in the treated soil.

An Innovative Technology Evaluation Report (ITER) describing the complete demonstration will be available in the summer of 1997.

#### For Further Information:

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**Table 1. Reductions Achieved in the Treatment and No-Treatment Plots**

Analyte	Baseline October 1993	Sampling 1 April 1994	Sampling 2 June 1994	Post Treatment September 1994	Overall % Reduction
<b>Treatment Plot</b>					
Total PAHs	1,710	619	221	98	94.3
TCPs	352	158	90	43(13.6) <sup>1</sup>	87.8(96.1) <sup>1</sup>
TRPH	7,300	NA	NA	932	87.3
<b>No-Treatment Plot</b>					
Total PAHs	1,312	1,155	982	776	40.9
TCPs	217	288	356	218 (240) <sup>1</sup>	0(0) <sup>1</sup>
TRPH	5,000	NA	NA	5,200	0

All data is mg/kg on a dry weight basis.

NA- Not analyzed.

PAHs- Polynuclear Aromatic Hydrocarbons.

TCPs- Total Chlorinated Phenols.

TRPH- Total Recoverable Petroleum Hydrocarbons.

<sup>1</sup>Data provided by GRACE Dearborn, based on analyses of split samples by an independent laboratory.

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